Beats

The Phenomenon in which the intensity of a Sound changes over time is called a beat. When two Sound Waves with Slightly different frequencies traveling in the Same direction with the Same amplitude superimposed on each other, the intensity of the resulting Sound increase is known as Waxing, and the resulting Sound decrease is known as Waning. If we have two Sound Sources with different frequencies and they are Played together, the ear may experience fluctuations in the intensity of the Sound.

For example,

when one tuning-fork vibrates 256 times Per Second and the other tuning-fork vibrates 260 times Per Second, both waves reaching the ear four times Per Second will reinforce each other and four times Per Second they will be opposite in their effects, trough coinciding with Crest, and will tend to extinguish each other, Such fluctuations in the intensity of Sound are known as beats.

Characteristics of Beats:

Some Characteristics of Beats are as follows:

1.) One beat is formed by one rise and one fall.

2.) Beat frequency is defined as the number of beats in one Second.

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3) The beat Period is defined as the time interval between two Successive beats.

4) In case f_1 and f_2 are the frequencies ($f_1 > f_2$) of the two Waves, then the beat frequency is given as, $f_b = f_1 - f_2$.

Graphical Analysis :

Graphical method helps in understanding the formation of beats between two notes. The graph fig-(i) depict the displacement curve for a note of frequency 20 hertz. The graph of fig(ii) depicts the displacement curve for a note of frequency 16 hertz.

The graph of fig (iii) depicts the resultant displacement curve when the notes 1 and 2 are Sounded Simultaneously. It is clear from the resultant displacement curve that There are four Positions of maximum intensity of Sound and four Positions of minimum intensity of Sound in one Second. Where 'a' denotes maxima and 'b' denotes minima. The number of Maxima or minima per Second is four, it is also equal to the difference in frequency between the two notes.

Let the frequency of one tuning fork is A=256 and a second tuning fork is B = 260. When these two tuning forks are sounded together after $-\frac{1}{8}\pi$ of a second, A completes 32 vibrations and B completes 32.5 vibrations, minimum sound is produced.

A completes 64 vibrations and B completes 65 vibrations Then maximum is Produced. Repeat this process again and it is found that in one second, four maxima and four minima are produced. Therefore we can hear four beats in one second.

The method of beats helps in determining the frequency of a tuning fork. Now take the tuning fork A of known frequency and tuning fork B is unknown frequency. These two tuning forks have nearly the same frequency. Determine the Number of beats Produced Per Second. Suppose N is the frequency of A and the Number of beats Produced Per Second is n. Hence, the frequency of B will be $N \pm n$.

The tuning fork B is loaded with a little wax for determining the correct value of B viz., $(N+n)$ or $(N-n)$. The frequency of tuning fork decreases when it is loaded with wax. In case the Number of beats Per Second

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increases, the original frequency of B is N - n and if the number of beats per second decreases, the original frequency of B is N + n.

Note:

1.) When a turning fork a loaded, its frequency decreases.

2.) When a turning fork is filed, its frequency increases.

Ex When a turning fork Sounded with a turning fork of frequency 256 Hz then it Produces 6 beats Per Second. The Same turning fork when Sounded with anothes turning fork of frequency 252 Hz Produces 2 beats Per Seemd. Detesmine the frequency of the turning fork.

Sol Suppose n is the frequency of the turning fork
The turning fork Produces 6 beats/sec with a turning fork of frequency 256 Hz

$\therefore n = 256 \pm 6 = 250$ or 262 Hz ——— (1)

The turning fork Produces 2 beats/sec with a turning fork of frequency 252 Hz

$\therefore a = 252 \pm 2 = 250$ or 254 Hz ——— (2)

The Common frequency of equn (1) & equn (2) is 250. Thus

$n = 250$ Hz

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Ex There are two tuning forks A and B That Produces 5 beats / sec. The frequency of A = 512. When B is filled, 5 beats / sec are again Produced. Calculate the frequency of B before and after filling.

Sol Given that frequency of A = 512

Beats Per Second = 5

Frequency of B before filling will be either

512 + 5 = 517, or 512 - 5 = 507

we know that, 5 beats / sec are generated again after filling, the frequency of B after filling is either.

512 + 5 = 517 or 512 - 5 = 507

Consider the frequency of B before filling as 517. The frequency increases after filling. Therefore the frequency of B after filling cannot be equal to 517 or 507. Therefore, the frequency of B cannot be equal to 517.

Consider the frequency of B before filling 507 After filling its frequency can be equal to 517

These will be the Possible Value

So, frequency of B before filling = 507

after filling = 517

Thus, the frequency of B before filling is 507 and after filling is 517.

Ex: A note produces 4 beats/sec with a turning fork of frequency 512 and 6 beats/sec with a fork of frequency 514. Calculate the frequency of the note.

Sol ① Given that, frequency of the tuning fork = 512

Beats/sec = 4

Thus the possible frequencies of the note are given as

$$\left.\begin{matrix} 512+4 \\ 512-4 \end{matrix}\right] = \left.\begin{matrix} 516 \\ 508 \end{matrix}\right] \quad \text{---- (1)}$$

② Given that, frequency of the tuning fork = 514

Beats / second = 6

Thus the possible frequencies of the note are given as

$$\left.\begin{matrix} 514+6 \\ 512+6 \end{matrix}\right] = \left.\begin{matrix} 520 \\ 508 \end{matrix}\right] \quad \text{---- (2)}$$

The common frequency in equ^{n} ① and equ^{n} ② is 508. Therefore the frequency of the note is 508.